IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appellant   :   Kenichiro NAGASAKA

Serial No.   :   10/822,199

For   :   ROBOT MOVEMENT CONTROL SYSTEM

Filed   :   April 9, 2004

Examiner   :   JEN, Mingjen

Art Unit   :   3664

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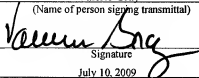
                                                    745 Fifth Avenue
                                                    New York, NY 10151
                                                    Tel. (212) 588-0800

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_____Valerie Gray_____
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REPLY BRIEF

Appeal Briefs-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Examiner's Answer dated May 12, 2009, having two month period for

reply set to expire on July 13, 2009 (July 12, 2009 being a Sunday), Appellant submits this reply

brief. A section of "Response to Examiner's Answer" is added to "vii   ARGUMENTS".

i   **REAL PARTY IN INTEREST**

The real party in interest is Sony Corporation, a Japanese Corporation with offices at 7-35 Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, 141-0001 Japan. The assignment of this application is recorded in the United States Patent and Trademark office on August 16, 2004, at Reel 015678 and Frame 0355.

ii   **RELATED APPEALS AND INTERFERENCES**

Upon information and belief, the undersigned attorney does not believe that there is any appeal or interference that will directly affect, be directly affected by or have a bearing on the Board's decision in the pending appeal.

iii   **STATUS OF THE CLAIMS**

This application was filed in the U.S. Patent Office with claims 1-12 on April 9, 2004 and assigned Application Serial No. 10/822,199. This application claims the benefit of Japanese Patent Application No. JP/2003-106166, filed on April 10, 2003.

A Non-Final Office Action was issued on September 7, 2007, rejecting claims 1, 2, 4-9, and 11-12 under 35 U.S.C. §102(b) as allegedly anticipated by U.S. Patent No. 5,294,873 to Seraji (hereinafter, merely "Seraji"). Claims 3 and 10 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Seraji in view of U.S. Patent No. 6,853,881 to Watanabe et al. (hereinafter, merely "Watanabe").

Appellant filed a reply on January 18, 2008. The response amended claims 1, 7, and 8.

A Final Office Action was issued on April 29, 2008, rejecting claims 1, 2, 4-9, and 11-12 were rejected under 35 U.S.C. §102(b) as allegedly anticipated by Seraji and rejecting claims 3 and 10 under 35 U.S.C. §103(a) as allegedly unpatentable over Seraji in view of Watanabe.

Appellant filed a reply on June 30, 2008, traversing the rejections without amendments.

An Advisory Action was issued on July 14, 2008.

Appellant filed a Notice of Appeal and Pre-Appeal Brief Request for Review on July 29, 2008.

A Notice of Panel Decision for Pre-Appeal Brief Review was issued on October 3, 2008.

This Appeal Brief is being filed pursuant to the Notice of Panel Decision for Pre-Appeal Brief Review.

An Examiner's Answer was issued on May 12, 2009.

This Reply Brief is being filed pursuant to the Examiner's Answer issued on May 12, 2009.

Accordingly, the status of the claims may be summarized as follows:

Claims Allowed:	None.
Claims Rejected:	1-12.
Claims Appealed:	1-12.
Claims Canceled:	none

The rejected claims 1-12 are set forth in the Appendix attached hereto.

Appellant appeals the Final Rejection of claims 1-12, which constitute all of the currently pending claims in this application.

iv   STATUS OF THE AMENDMENTS

Appellant believes that all the submitted Amendments to the claims have been entered.

V.   SUMMARY OF THE CLAIMED SUBJECT MATTER

A.   Brief Summary of the Invention

This invention relates generally to a walking robot and a movement control system. The robot has a plurality of movable parts and joints forming neck, body, legs, and arms and can simultaneously execute multiple tasks. The control system determines the driving amounts of each joint satisfying geometric and dynamic movement constraints of each task.

B.   Detailed Summary of Each Independent Claim

Independent claims 1, 7, and 8 are summarized below. Each of the independent claims 1, 7, and 8 is directed to a movement control system, respectively.

Citations to Figures and Specification locations are provided. However, such citations are provided merely as examples and are not intended to limit the interpretation of the claims or to evidence or create any estoppel.

Independent Claim 1

Independent claim 1 is directed to a movement control system for a robot having a base and a plurality of movable regions connected to the base (Figure 1 and Figure 3). The system includes fundamental constraint-condition setters (page 23, line 20 – page 24, line 7, and element 2-4 in Figure 3; page 25, lines 2-11, and element 2-5 in Figure 3), a constraint-condition setting unit (page 24, lines 8-16, and element 2-1 in Figure 3; page 25, lines 11-20, and element 2-2 in Figure 3), and a drive amount determining unit (page 26, line 20 – page 27, line 4, and element 2-10 in Figure 3).

The fundamental constraint-condition setters set movement constraint-conditions, which are imposed in accordance with a task and a movement state applied to the robot, for each kind of constraint (page 23, line 20 – page 24, line 7, and element 2-4 in Figure 3; page 25, lines 2-11, and element 2-5 in Figure 3).

The constraint-condition setting unit imposes the movement constraint conditions of the entire robot necessary for a state variation of the robot by selectively using the appropriate fundamental constraint-condition setter in accordance with a movement-constraint requirement produced during execution of a task and a movement of the robot (page 24, lines 8-16, and element 2-1 in Figure 3; page 25, lines 11-20, and element 2-2 in Figure 3). The drive-amount determining unit determines a drive amount of each of the movable regions so as to satisfy the entire movement-constraint conditions set by the constraint-condition setting unit (page 26, line 20 – page 27, line 4, and element 2-10 in Figure 3).

According to this invention, the movement constraint-conditions includes conditions corresponding to constraints regarding to an original point position of a link, a link posture, a gravity center position of a link, a joint angle, a gravity center position of the robot, or an entire angular momentum (page 23, lines 8-16).

Independent Claim 7

Independent claim 7 is directed to a movement control system for a robot having a base and a plurality of movable regions connected to the base (Figure 1 and Figure 3). The system includes fundamental redundancy drive-method setters (page 26, lines 4-10, and element 2-6 in Figure 3), a redundancy drive-method setting unit (page 26, lines 12-19, and element 2-3 in

Figure 3), and a drive-amount determining unit (page 26, line 20 – page 27, line 4, and element 2-10 in Figure 3).

The fundamental redundancy drive-method setters set redundancy drive-methods, which are changed in accordance with a task and a movement state applied to the robot, for each kind of norm (page 26, lines 4-10, and element 2-6 in Figure 3). The redundancy drive-method setting unit sets redundancy drive-methods of the entire robot by selectively using the appropriate fundamental redundancy drive-method setter in accordance with a requirement for changes generated during execution of a task and a movement of the robot (page 26, lines 12-19, and element 2-3 in Figure 3).

The drive-amount determining unit determines a drive amount of each of the movable regions so as to satisfy the redundancy drive-method set by the redundancy drive-method setting unit (page 26, line 20 – page 27, line 4, and element 2-10 in Figure 3).

According to this invention, the redundancy drive-method is set to minimize system state changes and target state deviation (page 25, line 21 – page 26, line 1).

Independent Claim 8

Independent claim 8 is directed to a movement control system for a robot having a base and a plurality of movable regions connected to the base (Figure 1 and Figure 3). The system includes equality-constrain condition setters (page 23, line 20 – page 24, line 7, and element 2-4 in Figure 3), an equality-constraint condition setting unit (page 24, lines 8-16, and element 2-1 in Figure 3), inequality-constraint condition setters (page 25, lines 2-11, and element 2-5 in Figure 3), an inequality-constraint condition setting unit (page 25, lines11-20, and element 2-2 in Figure 3), fundamental redundancy drive-method setters (page 26, lines 4-10, and element 2-6 in Figure

3), a redundancy drive-method setting unit (page 26, lines 12-19, and element 2-3 in Figure 3), and a drive-amount determining unit (page 26, line 20 – page 27, line 4, and element 2-10 in Figure 3).

The equality-constraint condition setters express movement constraint-conditions, which are imposed in accordance with a task and a movement state applied to the robot, for each kind of constraint by a linear equality equation of a variation of a state variable (page 23, line 20 – page 24, line 7, and element 2-4 in Figure 3). The equality-constraint condition setting unit imposes movement-constraint conditions of the entire robot necessary for a state variation of the robot by selectively using the appropriate equality-constraint condition setter in accordance with a requirement for a movement constraint generated during execution of a task and a movement of the robot (page 24, lines 8-16, and element 2-1 in Figure 3).

The inequality-constraint condition setters express movement constraint-conditions, which are imposed in accordance with a task and a movement state applied to the robot, for each kind of constraint by a linear inequality equation of a variation of a state variable (page 25, lines 2-11, and element 2-5 in Figure 3). The inequality-constraint condition setting unit imposes movement-constraint conditions of the entire robot necessary for a state variation of the robot by selectively using the appropriate inequality-constraint condition setter in accordance with a requirement for a movement constraint generated during execution of a task and a movement of the robot (page 25, lines 11-20, and element 2-2 in Figure 3).

The fundamental redundancy drive-method setters set redundancy drive-methods, which are changed in accordance with a task and a movement state applied to the robot, for each kind of norm (page 26, lines 4-10, and element 2-6 in Figure 3). The redundancy drive-method setting unit sets redundancy drive-methods of the entire robot by selectively using the

appropriate fundamental redundancy drive-method setter in accordance with a requirement for

changes generated during execution of a task and a movement of the robot (page 26, lines 12-19,

and element 2-3 in Figure 3).

The drive-amount determining unit determines a drive amount of each of the movable

regions so as to entirely satisfy equality and inequality-constraint conditions of the entire robot

set by the equality-constraint condition setting unit and the inequality-constraint condition setting

unit, and to entirely satisfy redundancy drive-methods of the entire robot set by the redundancy

drive-method setting unit (page 26, line 20 – page 27, line 4, and element 2-10 in Figure 3).

According to this invention, the movement constraint-conditions includes conditions

correspond to constraints regarding to an original point position of a link, a link posture, a

gravity center position of a link, a joint angle, a gravity center position of the entire robot, or an

entire angular momentum (page 23, lines 8-16). The redundancy drive-method is set to

minimize system state changes and target state deviation (page 25, line 21 – page 26, line 1).

vi   GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 2, 4-9, and 11-12 were rejected under 35 U.S.C. §102(b) as allegedly

anticipated by Seraji.

Claims 3 and 10 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over

Seraji in view of U.S. Patent No. 6,853,881 to Watanabe et al. (hereinafter, merely "Watanabe").

vii   ARGUMENTS

The arguments are directed to at least two features recited in independent claims 1, 7, and

8. Independent claim 1 recites <u>wherein movement constraint-conditions comprises conditions</u>

corresponding to constraints regarding to an original point position of a link, a link posture, a

gravity center position of a link, a joint angle, a gravity center position of the robot, or an entire

angular momentum. Independent claim 7 recites wherein the redundancy drive-method is set to

minimize system state changes and target state deviation. The two features identified above are

both recited in independent claim 8.

The above-identified features were rejected under 35 U.S.C. §102(b) in the Final Office

Action dated April 29, 2008. Appellant presented arguments, traversing the rejections in a reply

to the Final Office Action. In the Advisory Action dated July 14, 2008, explicit and specific

reasons used for the rejection were stated in reply to Appellant's arguments.

Appellant respectfully submits the following arguments for traversing the rejections in

the Office Action and reasons stated in the Advisory Action. Independent claims 1, 7, and 8 are

argued separately.

I.   Rejections of Claims 1, 2, 4-9, and 11-12 Under 35 U.S.C. §102(b) By Seraji

    A.   Independent Claims 1, 7, and 8

    Claim 1 recites, *inter alia*:

> "…wherein movement constraint-conditions comprises conditions
> corresponding to constraints regarding to an original point position
> of a link, a link posture, **a gravity center position of a link**, a joint
> angle, **a gravity center position of the robot, or an entire
> angular momentum**" (emphasis added)

Thus, claim 1 recites that movement constraint-conditions comprises conditions

corresponding to constraints regarding, *inter alia*:

    1.   a gravity center position of a link;

    2. a gravity center position of the robot; or

    3. an entire angular momentum.

The Final Office Action (see page 3) relies on equations 1-10 of Seraji to reject the above-identified features of claim 1. Specifically, equation 7 of Seraji is used to reject a constraint of a gravity center position of a link. Equation 8 of Seraji is used to reject a constraint of a gravity center position of a robot. Equation 10 of Seraji is used to reject constraint of an entire angular momentum.

The Advisory Action further explains that "the point mass (in equation 7 and equation 8) varies with respect to the robot movement angle and therefore changes the gravity center position and changes payload correspondingly", and that "equation 10 further exhibits the dynamic model of the robot, which corresponding the robot angular momentum".

Appellant respectfully disagrees with the rejection in the Final Office Action and the Advisory Action. Appellant respectfully submits that the cited portion of Seraji fails to disclose or suggest the above-identified features.

Specifically, equation 7 of Seraji, which is used by the Final Office Action to reject a constraint of a gravity center position of a link, calculates a static joint torque: $T_p = p J_e^T g$, where T_p is the static torque, p is a point mass, J_e^T is an end-effect Jacobian, and g is the gravitational acceleration. Appellant respectfully submits that <u>nothing in equation 7 of Seraji discloses a gravity center position of a link</u>. Appellant submits that the point mass, if treated as a part of a link, affects the gravity center position of such a link. However, <u>merely using a point mass in an equation does not disclose or teach that the gravity center position of the link is under consideration in such an equation</u>. Appellant further submits that nothing in Seraji discloses or teaches a constraint of a gravity center of the robot, as recited in claim 1.

Frommer Lawrence & Haug LLP
745 Fifth Avenue
New York, NY 10151
212-588-0800

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Equation 8 of Seraji calculates <u>weighted squares</u> of the static joint torque of equation 8. The weighted square does not disclose or suggest a gravity center position of the robot. Therefore, equation 8 fails to disclose or teach the above-identified features due to reasons similar with those of equation 7.

Equation 10 of Seraji expresses dynamics of a typical joint,

$$\tau_i = M_{ii}(\theta)\ddot{\theta} + \sum_{j=1 j \neq i}^{n} M_{ij}(\theta)\ddot{\theta}_j + N_i(\theta,\dot{\theta}) + G_i(\theta).$$ Appellant respectfully submits that equation 10

fails to disclose or teach a constraint of an entire angular momentum. Appellant submits that an angular momentum is determined by the product of the moment of inertia and angular velocity,

$L = I\dot{\theta}$. It is worth noting that the angular velocity, $\dot{\theta}$, is a first derivative of angle. Equation 10 does not disclose or teach a component that shows a product of the moment of inertia and a first derivative of an angle.

By merely stating that equation 10 of Seraji is a dynamic equation, the Final Office Action and Advisory Action fail to point out specific components in equation 10 that renders claim 1 unpatentable. On the contrary, Appellant's analysis of equation 10 clearly shows that Seraji fails to teach or suggest the above-identified features of claim 1.

Therefore, Appellant respectfully submits that claim 1 is patentable.

Claim 7 recites, *inter alia*:

> "...**wherein the redundancy drive-method is set to minimize system state changes and target state deviation.**" (emphasis added)

The Office Action (see page 4) relies on column 24, lines 5-column 29, lines 40 to reject

<u>wherein the redundancy drive-method is set to minimize system state changes and target state</u>

deviation, as recited in claim 7 (emphasis added). The cited portion of Seraji teaches an

optimization method of the objective functions (see equation 89). Seraji describes that "the

projection of the gradient of the objective function onto the null-space of the end-effector

Jacobian must be zero for optimality." (see column 26, lines 50-55) Appellant respectfully

submits that the objective functions such as equations 6, 9, and 13 do not involve a target state

such as a target joint angel. Appellant respectfully submits that the null space of Seraji does not

involve a target state. Therefore, the optimization method of Seraji does not minimize...target

state deviation, as recited in claim 7.

Therefore, Appellant respectfully submits that claim 7 is patentable.

Claim 8 recites, *inter alia*:

> "...wherein movement constraint-conditions comprises conditions
> corresponding to constraints regarding to an original point position
> of a link, a link posture, **a gravity center position of a link**, a joint
> angle, **a gravity center position of the robot, or an entire
> angular momentum,**
>
> **wherein the redundancy drive-method is set to minimize
> system state changes and target state deviation.**" (emphasis
> added)

For reasons similar to those described above with regard to independent claims 1 and 7,

independent claim 8 is also patentable.

B.   Dependent Claims 2, 4-6, 9, and 11-12

Dependent claims 2, 4-6, 9, and 11-12 in this application are each dependent from

one of the independent claims discussed above, and are therefore patentable for at least the same

reasons. Since each dependent claim is also deemed to define an additional aspect of the

invention, however, the individual reconsideration of the patentability of each on its own merits is respectfully requested.

    C.   <u>Response to Examiner's Answer</u>

       The Examiner's Answer states (page 12) that Seraji is required to show only one of "an original point position of a link, a link posture, a gravity center position of a link, a joint angle, a gravity center position of the robot, or an entire angular momentum" for the rejections. Appellant respectfully disagrees. Claim 1 recites fundamental constraint-condition setters and a constraint-condition setting unit. Firstly, <u>the fundamental constrain-condition setters set all</u> the constrain conditions, and then, <u>the constraint-condition setting unit selectively imposes</u> these conditions. Since the setting unit performs the selecting function, each of the above-identified constraint conditions is required to be pre-set by the fundamental constrain-condition setters. Accordingly, Seraji is required to disclose or suggest each of the above-identified constraint conditions.

       The Examiner's Answer (see page 11) relies on the gravitational torque of Seraji to reject the gravity center position of a link of claim 1. Appellant respectfully disagree. Appellants respectfully submit the gravitational torque and the gravity center position are not the same technical concept. Even through the gravitational torque and the gravity center position may be related in some cases, the gravitational torque may be obtained without any knowledge of a gravity center position. Merely knowing a constraint-condition involving the gravitational torque, a person with ordinary skills in the art does not know another constraint-condition involving the gravity center position.

The Examiner's Answer (see page 12) relies on equation 8 to reject the gravity center position of the robot of claim 1. Appellant respectfully disagrees. Equation 8 of Seraji calculates <u>a summation of an objective function based on the gravitational torque</u>. Equation 8 does not disclose or suggest a gravity center position of the robot.

The Examiner's Answer (see page 14) combines equations 10 and 15 of Seraji to reject the entire angular momentum of claim 1. Specifically, the Examiner's Answer states that equation 15 shows an angular momentum component and by applying equation 15 to equation 10, an entire angular momentum is obtained. Appellant respectfully disagrees. Equation 15 alone is merely to calculate an end-effector Cartesian mass matrix and is NOT a constraint condition. Furthermore, equation 15 is to calculate $Ny(\theta, \theta)$ that CANNOT be used to replace $Ny(\theta, \dot{\theta})$ in equation 10.

The Examiner's Answer (see pages 11 and 13) further relies on inherent properties to rejection constrain conditions regarding to <u>a gravity center position of a link</u>, <u>a gravity center position of the robot, or an entire angular momentum</u>, as recited in claim 1. Appellant respectfully disagrees. Appellant submits that constrain conditions regarding to <u>a gravity center position of a link</u>, <u>a gravity center position of the robot, or an entire angular momentum</u> are not inherent for controlling movement of a robot. For example, Patent No. 5,740,329, one reference cited by the Office Action dated April 29, 2008(see reference F in Form PTO-892 of the Office Action), uses none of the above-identified constrain conditions for controlling the movement of a robot wrist.

The Examiner's Answer (see page 14) relies on equation 89 of Seraji to reject <u>wherein the redundancy drive-method is set to minimize system state changes and target state deviation</u>, as recited in claim 8. Appellant respectfully disagrees. Equation 89 of Seraji

minimizes an objective function. All the objective functions of Seraji, such as Lg, Lp, Lmi, Lf,

Lv, Ls, and Lc, involve <u>only</u> a projected value. Therefore, none of the objective functions such

as described in Seraji relates to a <u>target state deviation that represents a difference between a</u>

<u>projected value and a targeted value,</u> as recited in claim 8.

II.   Rejections of Claims 3 and 10 Under 35 U.S.C. §103(a) Over Seraji and Watanabe

        Dependent claims 3 and 10 in this application are each dependent from independent

claims 1 and 8 discussed above, and are therefore patentable for at least the same reasons.
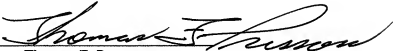

CONCLUSION

        For the reasons discussed above, claims 1-12 are patentable. It is, therefore,

respectfully submitted that the Examiner erred in rejecting claims 1-12, and Appellant requests a

reversal of these rejections.

        The Commissioner is hereby authorized to charge any additionally required fee,

or to credit any overpayment in such fees, to Deposit Account No. 50-0320.

                                        Respectfully submitted,

                                        FROMMER LAWRENCE & HAUG LLP
                                        Attorneys for Appellant

                                        By _____
                                           Thomas F. Presson
                                           Reg. No. 41,442
                                           (212) 588-0800

APPENDIX I

CLAIMS ON APPEAL

1.   (Previously Presented) A movement control system for a robot having a base and a plurality of movable regions connected to the base, the system comprising:

fundamental constraint-condition setters for setting movement constraint-conditions, which are imposed in accordance with a task and a movement state applied to the robot, for each kind of constraint;

a constraint-condition setting unit for imposing the movement constraint conditions of the entire robot necessary for a state variation of the robot by selectively using the appropriate fundamental constraint-condition setter in accordance with a movement-constraint requirement produced during execution of a task and a movement of the robot; and

a drive-amount determining unit for determining a drive amount of each of the movable regions so as to satisfy the entire movement-constraint conditions set by the constraint-condition setting unit,

wherein movement constraint-conditions comprises conditions corresponding to constraints regarding to an original point position of a link, a link posture, a gravity center position of a link, a joint angle, a gravity center position of the robot, or an entire angular momentum.

2.   (Original) A system according to claim 1, wherein the plurality of movable regions comprise at least an upper limb, a lower limb, and a body section.

3.   (Original) A system according to claim 1, wherein a posture angle of the entire robot is

expressed using a virtual joint angle of a virtual link.

4.   (Original) A system according to claim 1, wherein each of the fundamental constraint-condition setters for each kind of constraint expresses movement constraint conditions imposed in accordance with a task and a movement state of the robot as a linear equality of a variation of a state variable.

5.   (Original) A system according to claim 4, wherein each of the fundamental constraint-condition setters expresses a constraint equation by a Jacobian form.

6.   (Original) A system according to claim 1, wherein each of the fundamental constraint-condition setters expresses a movement constraint condition imposed in accordance with a task and a movement state of the robot as a linear inequality equation of a variation of a state variable.

7.   (Previously Presented) A movement control system for a robot having a base and a plurality of movable regions connected to the base, the system comprising:

        fundamental redundancy drive-method setters for setting redundancy drive-methods, which are changed in accordance with a task and a movement state applied to the robot, for each kind of norm;

        a redundancy drive-method setting unit for setting redundancy drive-methods of the entire robot by selectively using the appropriate fundamental redundancy drive-method setter in accordance with a requirement for changes generated during execution of a task and a movement of the robot; and

a drive-amount determining unit for determining a drive amount of each of the movable regions so as to satisfy the redundancy drive-method set by the redundancy drive-method setting unit,

wherein the redundancy drive-method is set to minimize system state changes and target state deviation.

8.   (Previously Presented) A movement control system for a robot having a base and a plurality of movable regions connected to the base, the system comprising:

equality-constraint condition setters for expressing movement constraint-conditions, which are imposed in accordance with a task and a movement state applied to the robot, for each kind of constraint by a linear equality equation of a variation of a state variable;

an equality-constraint condition setting unit for imposing movement-constraint conditions of the entire robot necessary for a state variation of the robot by selectively using the appropriate equality-constraint condition setter in accordance with a requirement for a movement constraint generated during execution of a task and a movement of the robot;

inequality-constraint condition setters for expressing movement constraint-conditions, which are imposed in accordance with a task and a movement state applied to the robot, for each kind of constraint by a linear inequality equation of a variation of a state variable;

an inequality-constraint condition setting unit for imposing movement-constraint conditions of the entire robot necessary for a state variation of the robot by selectively using the appropriate inequality-constraint condition setter in accordance with a requirement for a movement constraint generated during execution of a task and a movement of the robot;

fundamental redundancy drive-method setters for setting redundancy drive-methods, which are changed in accordance with a task and a movement state applied to the robot, for each kind of norm;

a redundancy drive-method setting unit for setting redundancy drive-methods of the entire robot by selectively using the appropriate fundamental redundancy drive-method setter in accordance with a requirement for changes generated during execution of a task and a movement of the robot; and

a drive-amount determining unit for determining a drive amount of each of the movable regions so as to entirely satisfy equality and inequality-constraint conditions of the entire robot set by the equality-constraint condition setting unit and the inequality-constraint condition setting unit, and to entirely satisfy redundancy drive-methods of the entire robot set by the redundancy drive-method setting unit,

wherein movement constraint-conditions comprises conditions correspond to constraints regarding to an original point position of a link, a link posture, a gravity center position of a link, a joint angle, a gravity center position of the entire robot, or an entire angular momentum, and

wherein the redundancy drive-method is set to minimize system state changes and target state deviation.

9.   (Original) A system according to claim 8, wherein the plurality of movable regions comprise at least an upper limb, a lower limb, and a body section.

10.   (Original) A system according to claim 8, wherein a posture angle of the legged walking robot is expressed using a virtual joint angle of a virtual link.

11.   (Original) A system according to claim 8, wherein each of the equality-constraint condition setters expresses a constraint equation by a Jacobian form.

12.   (Original) A system according to claim 8, wherein the drive-amount determining unit comprises: a quadratic programming-problem solver for solving a variation of a state variable of the robot by formulating equality and inequality-constraint conditions of the entire robot and redundancy drive-methods of the entire robot as quadratic programming-problems; and an integrator for calculating a state of the robot at a succeeding time by integrating a variation of a state variable.

APPENDIX II

EVIDENCE

None

APPENDIX III

RELATED PROCEEDINGS

None